CHAPTER 2

2 SATELLITE SYSTEMS

This means networks intended for users on the Earth but which have some equipment in space, i.e. a satellite. Different satellites do different jobs, such as taking weather pictures or finding accurate positions. Communications satellites are usually quite different and are sometimes referred to as COMSATS, though this is actually the name of a major satellite consortium. Other words you may hear are the word for satellite communications in general, SATCOMS, and the word for a satellite phone terminal, SATPHONE.

Comsats in turn come in two different types

- **GEO** (Geostationary), such as the COMSAT and INMARSAT systems. And the regional 'spot beam' systems such as AMSC.
- **LEO** (Low Earth Orbiting) such as Iridium, ICO, Globalstar, Odysey, Constellation, teledesic, Ellipso, Oscar and Satellife.

Low Earth Orbiting (LEO) are of the same class that will be used for future systems intended to bring Global hand-held phones that fit into the back pocket and work just like a 'portable' 'mobile phone'. Though scheduled for availability in 1998, they may not be working until the first decade of the next century.[28]

There is also a Packet data system by LEO satellite, with the satellite acting as a world roaming mailman beaming messages up and down as it passes. The system is very cheap to run and was invented for the benefit of aid agencies with low budgets. There is information about this in the appendix,(see SatelLife and VITA). We will come back to LEO systems later, but for now let's get on with Geostationary systems.

2.1 THE INMARSAT SYSTEM

The most practical and the only global satellite system for use by disaster Relief field units at the time of writing (1996) is the International Mobile Satellite Organisation's system (INMARSAT). This system was set up as long ago as 1976 and was at first intended for use by, for example, large cargo ships. This explains why many seafaring terms such as the" Ship Earth Station" (SES) and "Coast Earth Station" (CES) are used in the INMARSAT system.

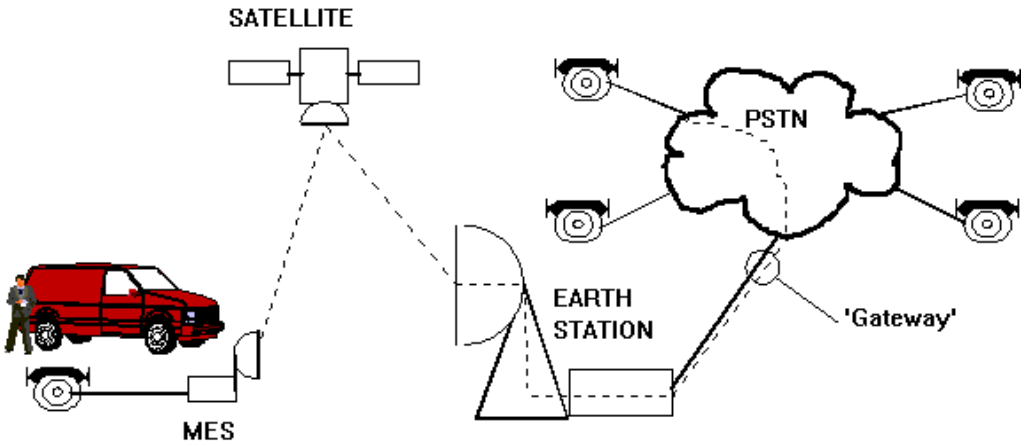

Fig 10 *The INMARSAT system connects you to the PSTN, TELEX or ISDN*

Since then however, many more land based users have started to use the system, so the terms Land Earth Station (LES) can be used instead of CES and Mobile Earth Station (MES) instead of SES. Do not be confused if you see these words, they are exactly the same thing as before, but by another name. The only difference is that SESs tend to be physically larger and are intended for permanent installation on board a ship. The other difference is that ships tend to wallow about while the call is in progress, so the antenna dish (protected by a egg shaped radome) needs to have a complex and expensive tracking system to keep it pointing at the satellite as the ship rolls and pitches around, and as it changes course.

Most new MES's tend to be fitted inside briefcases and have disassembled antennas. this is why they are much cheaper and smaller, though their function is the same. It is taken for granted that an MES user will not move the dish once it has been assembled, therefore a tracking system is not required. Most also have removable antennas, which gives highly desirable flexibility. You can put the antenna outside, and make your call inside in the dry and warm.

The INMARSAT system utilizes four geostationary satellites and about 80 land earth stations dotted around the world and operated by various Telecomms companies. The British CES is 'Goonhilly' and is operated by BT. The MES (our kit in the field) links up to the satellite, then down

to the LES and then into the normal Phone, data, fax or TELEX system.

One awkward thing is that someone calling the MES has to dial a code for the correct satellite first, so the MES operators need to let everyone know which one his dish is pointing at. This is important because in many places in the world, such as Africa, two satellites are in view and either could be used. The choice will depend on where most of the calls from the MES are intended. The MES operator will consult his operating manual for this information, then inform all potential callers of the dialling code change to reach him. However there are some LES stations which try both just in case, ask your LES if in doubt. Another drawback is that the system won't work at all above about 70 degrees north or south. However since this is above the arctic and antarctic circles, you are unlikely to be working there without expert guidance and special equipment.

* NOTE

By far the biggest problems are not technical, but political. Some countries ban the use of **any** land mobile satellite equipment on their territory, or take up to 7 weeks to grant a licence, charging up to hundreds of USD per year for a licence for one terminal. That is a worst case scenario, usually it is much better than that, and the rules vary from country to country and day to day. The good news is that they **may** make an exception for Emergency relief and disaster mitigation units, in which case a fast track method must be employed. (See Licensing Chapter 5.) There is more information in the appendix.

There are 4 completely different System Technologies for INMARSAT at the moment, (though INMARSAT are working on another more advanced LEO version also, under the name ICO, (formally INMARSAT-P), to be introduced around the year 1998). The existing system technologies in 1996 are:-

- INMARSAT-A (Standard-A)
- INMARSAT-B (Standard-B)
- INMARSAT-C (Standard-C)
- INMARSAT-M (Standard-M)

2.1.1FOR INMARSAT-A

This one has all the 'bells and whistles'. It can handle telephone calls, by direct dial in and out, and the calls are always of very good quality. The lines are so clear that the channels can also be used to send Data via a modem or if you have the high speed data option,(so it can support Electronic Mailing), or FAX. Built in circuits in the MES makes the terminal output look just like a phone line, so anything that can connect to a phone line will just plug straight into the INMARSAT-A with no modifications needed.

It can also connect into a switchboard and be available to many users via a field telephone system. INMARSAT-A supports Full Duplex TELEX (this means a two way conversation could be held by TELEX).[29] It is reliable and easy to use. The latest equipment also enables the sending of full motion video (though not in real time) and good quality colour stills, with the installed 56/64 Kb/s high speed data option via ISDN. As a security precaution against unauthorised use, most terminals offer systems such as separate passwords required for each authorised user, with separate logging for each one.

2.1.2 AGAINST INMARSAT-A

The older equipment is quite big and heavy, being the size of one or sometimes two large suitcases and weighing about 30kg. Newer models weigh about 18kg, not including auxiliaries and generator.

It needs mains power (or a generator or inverter which are also big and heavy) and it can't be used on the move.

It is also the most expensive system. A typical unit may cost about 20,000 US Dollars or more for the High speed data options and calls cost about USD 6-8 per minute peak, USD4-5 off peak. (see appendix for details)

Most manufacturers have discontinued development on standard-A now, so it is likely to be left behind in the technology race in the future, though they will continue to support the existing models for many years hence.[30]

2.1.3 INMARSAT-B

This is the digital replacement for INMARSAT-A. It can do all the things that INMARSAT-A does, Phone, Data, FAX, TELEX, but at much lower call charges. This is achieved by more efficient use of the satellite and power. It can also provide high speed data links by ISDN services, but as these are more interesting to broadcasters and industrial users, because of their having higher budgets, I will not talk about them much more. However I am watching with great interest.

2.1.4 FOR INMARSAT-C

Standard C is a Store-And-Forward TEXT messaging system capable of connection to TELEX or data networks or sending text only messages from a mobile to a FAX machine. It has all the advantages of TEXT communications as already discussed. It is also much smaller and lighter than any other system being about shoe box sized and weighing about 5-10KG.

There are many different manufacturers in this field and INMARSAT-C related products continue to be developed and will continue to be improved upon for the foreseeable future. The system is very reliable and much loved by professionals everywhere. For example it is used by the UNDHA, MSF, Red Cross and dozens of others.

Unlike most other system satellite systems (except standard-M), it **can also be used on the move**, such as if fitted to a Land Rover, if non-directional antennas are used. There are also many models looking like a briefcase with the antenna built in to the lid.[31]

Text messages can be prepared off line by a Personal Lap Top Computer with all the huge advantages that users of PC will be familiar with as regards word processing. Power requirements can typically be met by batteries such as vehicle batteries. The equipment is usually very tough and highly reliable.

The latest application is for a remote version of CC:mail, a popular electronic mailing system. By use of the system, a person with an electronic mail account can continue to communicate from his account even from a remote location.

It is the cheapest satellite system costing around USD 5,000 per unit and calls costing about USD 2-3 per average message. Automatic Notification of delivery of message costs about 20c. Importantly, it uses little power and can run off batteries for days.

2.1.5 AGAINST INMARSAT-C

This is a text-only system and cannot send voice or graphical FAXes such as maps to or from a normal FAX machine. However script in Arabic and Chinese and the Cyrillic alphabet can be supported by special software, provided that the equipment is available at both ends of the link. TELEXES can only be in the reduced character set supported by those machines.

It is a little harder to learn to use, and doubly so for any person not computer literate as a laptop PC is usually the terminal. Those familiar with word processors will find it similar to use, only you press transmit instead of print when you are ready to send.

The whole system is only as reliable as your 'lap top' or terminal. The Standard-C gear is very tough but less so the drives in the laptop, you must purchase only the most trusted model or the system will not work, anyone who travels with 'lap tops' regularly will know what I mean. Good training and thorough preparation is a 'must'.

The same applies to power, you must keep the batteries charged in your PC, and budget your power wisely. Only experience will teach you the tricks you will need before you feel confident with your Lap Top PC. You must avoid the temptation to play games on your lap top in the boring evenings.

When in TELEX mode it does not sport full duplex 'chat back and forth' operation but can only send a message and then wait for a reply. This is called the 'Store and Forward' method.

2.1.6 FOR INMARSAT-M

INMARSAT-M is a direct dial in and out phone service via PSTN. Its designers wanted it to be the nearest thing to a mobile phone possible with geo stationary satellites, so its very easy to use and easy to teach. The cost of calls on standard-M is about half that of standard-A, at around USD 5.00 per minute or lower. The MES terminals are fairly compact by comparison with INMARSAT-A, or -B, being about briefcase sized and weighing about 10kg as opposed to the suitcase size and 20kg for standard-A.

Some later versions will be able to work from a moving vehicle. It is also able to send and receive FAX by the use of optional special circuits built in, a special separate socket and a separate phone number is then allocated to the fax socket on the terminal. By the middle of 95, it is expected to support DATA at the rate of 2.4Kb/s.

Some INMARSAT-M terminals can also be powered by their own internal batteries for 8hrs on standby and 1hr talk time. Being a new service many manufactures are still making them better and better yet, so we can expect quite exciting things from standard-M until it is superseded by the future LEO systems after the turn of the century. There has now been a few years experience with the system at time of writing, UNHCR and Red Cross are examples of organisations using the equipment and are reported to be very pleased with its reliability, some 7,500 were in use in by 1995.

2.1.7 AGAINST INMARSAT-M

The only thing against is the initial cost of the equipment, which will sell for around USD 15,000 plus tax. It is still subject to the same political problems as all other satellite systems, namely that the equipment may be banned or a very large customs duty be required. However the situation is better than for INMARSAT-A because of the lower emitted power from the unit. However it is rather slow in FAX mode, taking four times longer than standard A to send the same page and therefore costing twice as much.

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One big problem for operators using this equipment is that it is the victim of its own success. It is so easy to use and
gives such clear lines that a user can be seduced into dropping into a relaxed telephone style and taking 10 mins to say
something that could be said in 3. When you get your first bill from one of these you could wish that you hired a team
of Trappist monks. Three weeks of using one standard-A terminal in Zaire for the Rwandan operation cost the UNDHA CHF
29,800. Data or FAX modes are much more cost efficient than voice so they must be encouraged. As in all things, training
and discipline pay off in the long run.
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2.1.8 Data over Inmarsat

With the advent of Electronic Mailing, Internet and the World Wide Web, there is more and more interest in data over the Inmarsat system. Standard-A can support ordinary modems without modification but only certain models seem to work well, you must ask someone experienced before you choose your model. The others systems also offer data services but there are special complications that you must know about. My research on this topic is ongoing at the time of writing and so I have given a summary in the Appendix about my findings so far. At the moment you need good advice and support for serious use.

2.2 FLEET MANAGEMENT SYSTEMS

This is a rather exciting system whereby a trucking company manager, for example, can have an electronic map of the world in his personal computer, showing the position of all of his trucks and giving information about their status e.g. what they are loaded with. A further facility is that the manager is able to type a message into his computer, and have that message go immediately to one or all of his fleet.

However this is not a separate new network as such but is a clever combination of GPS (Global Positioning System) to give the truck's position and INMARSAT-C to transmit the position and other data about the load to the management centre and to dispatch orders to the driver from the management centre, the data being processed separately by software running in the company's own P.Cs.

It seems that the Air Traffic control Authorities are interested in this technology to supplement radar surveillance. The air version will be known as Automatic Dependent Surveillance (ADS). Traffic controllers are very, very cautious people, so if they are considering it, then this is a measure of it's state of maturity.

2.3 Regional satellite systems

Regional systems are usually implemented by only one satellite rather than several. Furthermore, the antennae on the satellite beam the energy into one area on the ground, known as the 'footprint' or 'zone'. Regional systems don't offer global coverage but rather only in the area inside the footprint. Each footprint can be very large, encompassing a whole country or economic group, for example. In the American Mobile Satellite Corporation version, one zone covers the whole of the East coast two further zones cover the midwest, while another the West coast of the USA. In that system, several zones are connected together to offer system coverage of the whole of North and Central America.

The charges for regional service are usually very much lower than for global systems, by half as much, So as long as you are sure that you will be working in the covered area, a Regional system may prove to be the most economical. It is thought that many new systems will emerge, so it is worth while checking the situation in your region frequently.

2.4 The LEO systems

Very few people doubt that the LEOs are by far the most important development in disaster Telecommunications in the near future. The very successful introduction of the 'mobile phone' systems all over the world have stimulated a demand for personal communications which is as unquenchable as it is profitable for the operators of these systems.

Normal mobile phone systems have the problem that they are provided by ground based 'Base Stations'. These need to be carrying at least 8 calls at a time in order to be economical, yet their range is limited to about 35km, so they are usually only provided in urban areas. Satellite systems have the disadvantage that they need bulky and usually fixed antenna systems to make them work, so this makes them hardly 'handy' and certainly not 'portable'.

The solution is to bring the satellites much lower to the ground (300 km) and so able to be contacted with a more convenient antenna suitable for mounting on a hand held 'phone. The problem is that 1) you need far more satellites to do this as each can now 'see' a smaller area. 2) they move much faster across the sky and so loose contact with the user after a few minutes, thus requiring 'handover' systems not unlike those used in mobile phone systems.

The different operators who have so far declared themselves (Iridium, ICO, Globalstar and Odyssey) each have different systems technologies for solving these problems, and need anything from 12 to 84 satellites to achieve global coverage. At the moment I don't know which of them will be the most successful and the technical differences are mostly of interest only to techno-buffs.

One thing I do know is that if they work as well as promised, and cost as little to operate as promised, then they could make everything else obsolete overnight! It is an open secret that the big Mobile phone makers, Motorola, Nokia and Ericsson are all spending a lot of money on developing 'dual standard' phones designed to work on the new LEO systems. The idea is that the phone will act as a normal mobile phone in an area where the system is provided. However it will automatically switch to the satellite system if either you have strayed out of the area where the system is provided, or if the normal system is out of order, for example because it has been destroyed by a disaster.

To add to the attraction of this very convenient personal communicator, all of the operators promise high speed data applications for their systems. There will also be built in position finding in the phones so that you won't need to carry a separate GPS receiver. You will have Phone, message pager, Data terminal and GPS in one hand held unit, all of which could be immune to damage from a disaster no matter of what scale.

The problems facing the new systems are that each is a very ambitious new technology, so progress with bringing their products to market may not be as rapid as they are forecast now. Each has pledged to start launching in 1998, which would put a strain on the world space launcher

industry even assuming no hitches at all.

Coverage may also be a problem in that signals may be too marginal to work inside buildings at all. It may be that you would have to be outside, with a clear view of the sky, to make a call. There could be severe hitches with data transmission at first as the air interface will be much more variable.

By far the biggest problem may be political. A government may see the system circling overhead as piracy or even technological imperialism. Persons could make calls from a countries sovereign territory without needing any government provided facilities, without asking and without paying a penny to the national purse. There are enormous diplomatic and political problems for the operators of the LEO systems to resolve. Probably for quite a while, there may be countries where use of these phones is prohibited or very large licence fees may apply. In fact a situation exactly the same as applies to the INMARSAT system now.

These are the promises and the problems, we will have to wait and see if it will be delivered. In any case a full service is unlikely to be working until around or after 2000-2010.

2.5 Satellite Dispatcher systems

It seems that most of the space operators are concentrating on fax, data and conventional telephony applications for their terminals. However there are some limitations with conventional telephony which we need to be aware of.

By phone, you can only talk to one person at a time. In the case of a large scale disaster, you may need to share information and ideas with as many as 10 persons at a time. If you had a three minute message to send to 10 persons, this will take you half an hour, presuming no hitches at all. This will cost you USD150 on call charges and use up a lot of your time that you need to spend on more important things. Even a conference call is not the answer as you will not be able to talk to 10 mobiles at once, and in any case you will be charged air time for each mobile, the bill could still be huge!

This is why such authorities as fire brigades don't use mobile phones even though they could afford them. With open channel systems, when one station speaks, all the others hear also, so that information is passed around in real time. When a station is now called for comment, he will not need a briefing as he has been getting a rolling briefing the whole time. This means that important officers can be out in the field putting their experience to use instead of sitting in a briefing room reacting to old news and smiling at the media.

In the past this was done by VHF repeater networks which were sadly, very short range. Around 50 KM was normal. But now this type of service is available by satellite with a resulting much larger range.

It seems to me that if all NGO's shared the same global satellite system which offered both data/phone and also this dispatch service, then co-ordination would be much easier. Units could join and un-join groups as they need in order to work together better. Also in dispatcher systems, there is **no charge for air time** of the satellite, rather a fixed monthly charge for activation of this service. This would keep the costs under strict control while removing monetary barriers to the more extensive use of these systems.

This is my private view, but I acknowledge that many people I respect have different views.

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[28] *Estimates vary from 1998 to 2010.*

[29] *However it is wise not to use the direct telex mode because it is very expensive to hold a conversation this way, with people thinking and then typing the answer. Better to send a message then go off line and wait for a response.*

[30] *INMARSAT promises to support Standard-A until at least 2005.*

[31] *These days the term transportable means man carryable but not intended to be operated while carried in the hand.*